

## REINFORCED LOCKING CONNECTOR

### RELATED APPLICATIONS

The present invention is a continuation-in-part of U.S. Patent Application Serial  
5 Number 10/202,514, filed July 23, 2002, the contents of which are herein incorporated by  
reference.

### FIELD OF THE INVENTION

The present invention relates to an automatically locking connector system for joining  
10 a first connector body with a second connector body.

### BACKGROUND OF THE INVENTION

Automatically locking connector systems are used for a variety of applications, such  
as electrical, fluidic, mechanical, optical, hydraulic or pneumatic systems, to provide a  
15 connection between various components and devices. A typical connector may comprise a  
female connector assembly and a male connector assembly that are designed to be engaged  
and disengaged with one another. Prior patents describe a coupling mechanism, having one  
coupler half that is inserted into the other half and a sleeve on one half, which rotates against  
a torsional spring force as a result of the camming action of complementary triangularly-  
20 shaped tabs on the sleeve and the inserted coupler half. The restoring force of the spring  
causes the sleeve to rotate into a locking position after the complementary tabs have passed  
each other. The tabs prevent disengagement of the coupler halves until the sleeve is twisted  
to permit the tabs to clear each other during uncoupling. For example, U.S. patent numbers  
5,067,909, 5,167,522 and 5,662,488, all of which are incorporated herein by reference,  
25 describe automatically locking couplers, in which a locking sleeve is rotated against a spring  
force during initial insertion of one coupler half into the other, and permitted to rotate back  
into a locking position upon completion of insertion.

With telescopically mating electrical connectors, such as a plug and a socket, it is  
30 often desirable or necessary to lock the two connector bodies together after their conductive  
contacts have been physically and electrically joined. Single conductor connectors with  
some form of bayonet joint may be rotated to a locking position. Multiple male and female  
contacts, however, must be slidably joined telescopically without rotation, and typically  
have used a pliable plastic connector body which is deformed as a catch on one connector

body rides over a detent on the other connector body to a locking position beyond the detent. If such a deforming latching body is frequently engaged and disengaged, the plastic tends to fatigue from the deformation. As a result, the latching mechanism eventually fails. In addition, care must be taken during assembly of the connector to ensure that the connectors  
5 fully engage with each other.

Most locking connectors are designed to lock in the mated position and must be manually disengaged. In certain applications, it is desirable that the connectors automatically disconnect when a force exceeding a predetermined level is applied to the connector  
10 assembly or a cable extending from the connector assembly. For example, requirements exist in some industries that a mated pair of connectors disengage (or break away) before the cable is damaged, the connector pair is damaged, personnel trip over the cord, electrodes connected to the connector are stripped off a patient (in medical applications) and/or attached  
equipment, such as an electronic device, falls and becomes damaged, falls from a shelf and  
15 crashes to the floor or falls in such a way to cause personal injury.

It may also be desirable to reinforce the connector to prevent accidental disengagement of the connector pair.

## 20 SUMMARY OF THE INVENTION

The present invention provides a reinforced locking connector. The present invention combines a self-latching arrangement with a manual de-coupling arrangement in a connector system. The locking connector comprises first and second tubular connector bodies having telescoping body portions and axially mating contacts, an annular collar rotatively  
25 held on the first body encircling the telescoping body portions and a spring inside the collar. The ends of the spring are confined between the first body and the collar so as to yieldingly resist rotation of the collar relative to the first body. Axially aligned tabs are provided on the collar and the second body for latching the first body and the second body together through a predetermined range of forces. The tabs include opposed flaring cam surfaces, which cause  
30 the collar to rotate relative to the second body as the first and second body are telescoped to a mated contact position. The cam surfaces guide the collar tab around the body tab, and the coiled spring yields as the collar is rotated by the cam tabs during contact mating to allow the collar tab to slide past the body tab. The spring then rotates the collar tab to a latching position axially behind the body tab, thereby locking the connector bodies in mated contact

position. The collar tab and the cam tab are configured to reinforce the connection between the first body and the second body to prevent accidental disconnection of the first and second bodies.

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## BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is an exploded isometric view of a connector system according to an illustrative embodiment of the invention with first and second connector bodies and a collar;

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FIG. 2 is an exploded side view, of the first body, collar and second body of the connector system according to an illustrative embodiment of the invention;

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FIG. 3 is an enlarged view of the second body, illustrating in detail the configuration of the camming tab.

FIG. 4 is an end elevation view of the first body viewed from a plane X--X between the collar and second body.

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FIG. 5 is an end elevation view of the collar viewed from a plane X--X between the collar and second body.

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FIG. 6 is an end elevation view of the second body viewed from a plane X--X between the collar and second body;

FIG. 7 illustrates a section on line 7--7 of FIG. 2 of the connector system.

FIGS. 8a and 8b illustrate the second connector body according to an alternate embodiment of the invention.

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FIG. 9 illustrates an alternate embodiment of the second body, wherein the camming tab is angled in a opposite direction to the camming tab of Figure 3 to increase the breakaway force.

## DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a self-latching connector system including one or more components configured to control the breakaway force of the connector system. The invention will be described below relative to illustrative embodiments. Those skilled in the art will appreciate that the present invention may be implemented in a number of different applications and embodiments and is not specifically limited in its application to the particular embodiments depicted herein.

Figure 1 illustrates a locking connector 10 according to an illustrative embodiment of the invention. According to the illustrative embodiment, the connector 10 is used in an electrical application, though one skilled in the art will recognize that the connector can be implemented in any suitable system. The connector 10 comprises a first connector body or plug 20 and a second connector body or receptacle 30 configured to receive and/or engage the first connector body 20. According to the illustrative embodiment the first connector body 20 is a male connector having a cylindrical shaped housing with male contacts 22 enclosed in recesses 23 of an insulative boss 24. The illustrative second connector body 30 is a female connector having a cylindrical shaped housing defining a cavity 34 for receiving the boss 26. The second body further includes female contacts 32 disposed in the cavity 34 for mating with the male contacts 22 of the first connector 20. The plug boss 24 telescopes into the cavity 34 of the second connector body or receptacle 30, such that the male contacts 22 axially mate with the female contacts 32 when the first body 20 engages the second body 30 along the longitudinal axis A-A. The second body may further include a flange 29 and threads 31 for mounting the second body in a panel with a nut or other suitable mating device.

An annular collar 40 is rotatably mounted on the first connector body 10 to latch the connector bodies 20, 30 together. When the two bodies are mated, the annular collar 40 encircles the boss 24 of the first body and the socket 34 of the second body to hold the connector bodies together. According to the illustrative embodiment, the collar 40 includes one or more internal radial stops 42 and the first connector body includes a first flange 110 having one or more passageways 120 extending longitudinally and configured to receive the stops 42 on the collar 40. An annular groove 130 is also formed on the first connector body 20 for receiving the internal radial stops 42 of the collar.

The collar 40 is mounted to the first body 20 by sliding the collar 40 along the longitudinal axis A-A over the boss 24, such that the internal radial stops 42 on the collar 40 are admitted through the passageways 120 on the first body and into the annular groove 130. The annular groove 130 axially confines the stops and holds the collar 40 rotatively around the first body 10. The stops limit the amount of rotation of the collar to a range of about forty degrees. One skilled in the art will recognize that other suitable means of rotatably locking the annular collar 40 to the first connector body 20 may be used in accordance with the teachings of the invention.

The collar further includes at least one camming tab 210 configured to engage one or more camming tabs 220 on the second body to lock the connector bodies together. According to the illustrative embodiment, the camming tabs 210, 220 comprise opposing, pie-shaped protrusions, though other configurations may be used according to the present invention. The camming tabs 210, 220 comprise opposing points 331, 332, respectively, and two camming surfaces 341, 342, respectively, flaring away from each point to intersection with a back surface 361, 362, respectively.

According to the illustrative embodiment, one or more of the back surfaces 361, 362, preferably the back surface 362 on the second connector 30, is angled relative to a radial axis B-B that extends along the direction of rotation of the collar and perpendicular to the longitudinal axis A-A, as shown in detail in Figure 3 to facilitate automatic release of the connector bodies when a predetermined force is applied to the connector system. The angled back surface 362 of the receptacle tab contrasts the camming tabs described in U.S. Patent Numbers 5,067,909, 5,167,522 and 5,662,488, which extend in the direction of rotation of the collar, perpendicular to the longitudinal axis A-A. As shown, the back surface 362 is inclined from the radial axis B-B to form a ramp that extends at a forward angle, i.e., in a direction that is axially and radially forward relative to a back point 335 of the camming tab 220. As used herein, “radially” refers to the direction of rotation of the collar, axis B-B, and “axially” refers to the direction of the axis A-A, i.e. along the longitudinal axis of the connector system. “Radially forward” refers to the direction of rotation of the collar indicated by the marker 300 on the collar, i.e., toward the ramp 370 from the tab 220. “Axially forward” refers to the direction of movement of the first body relative to the second body during disengagement. “Radially backward” refers to a direction opposite the radially forward direction and “axially backward” refers to the direction opposite the axially forward

direction, i.e., the direction of movement of the first body relative to the second body during engagement. According to an illustrative embodiment, the back surface of the receptacle camming tab extends at an angle  $\theta$ , relative to the line B-B, as shown in Figure 3, and relative to the back surface of the camming tabs described in U.S. Patent Number 5,067,909. In the  
5 embodiment shown in Figure 3, the angle  $\theta$  extends between about 5 degrees and about 45 degrees in the axially forward direction. The operation of the camming tabs will be described in detail below.

A coiled spring 47 may be provided for biasing the collar 40 into a normal position  
10 when the collar is mounted on the first connector body 20. The coiled spring 47, illustrated as a round wire of spring metal, though any suitable mechanism for biasing the collar may be used, is also confined in the annular groove 130 of the first body 20. The spring 47 may be anchored at a first end inside the collar at a first stop 142 (shown in Figure 5) and at a second end in a small recess 138 in the groove 130. As shown in Figure 6, the spring 47 is biased  
15 yieldingly to constantly urge the collar stops 42 to a normal position abutting the opposed stops 190 in the groove 130. In the rest position, as described in detail below, the camming tabs 210 provided on the collar 40 are located relative to the male contacts 22 of the first body such that the collar camming tabs 210 and male contacts 22 are in matching alignment with corresponding camming tabs 220 on the second body 20 and the female contacts 32 on  
20 the second body 20, respectively.

The insulative boss 24 of the first connector body 10 further includes longitudinal keyways 260 and 270, which receive keys 230 and 240 formed on an inner surface of the receptacle cavity on the corresponding female connector to assure correct angular alignment  
25 during mating engagement. The keys may comprise a relatively narrow key 230 and a relatively wide key 240 and the keyways may comprise a relatively narrow keyway 260 for receiving the narrow key 230 and a relatively wide keyway 270 for receiving the wide key 240. The keys and keyways are arranged such that when the first connector body 20 and the second connector body 30 are engaged (i.e. the keys are inserted in the corresponding  
30 keyways), the collar camming tabs 210 have substantially the same angular relationship to the male contacts as the receptacle camming tabs have to the female contacts when the collar is in the rest position.

Index marks may also be provided as a visual aid to the correct angular alignment in alignment of the bodies 20, 30. For example, the illustrative connector system includes a first index mark 290 on the collar, a second index mark 280 on the first body and a third index mark 310 on the second body, which align when the connector bodies are properly engaged.

- 5 The mark 290 on the collar may further include an arrowhead 300 indicating the direction in which the collar 40 can be rotated from the normal position during the two operations of locking engagement and disengagement of the two bodies.

10 To lock the male and female connector together, the markers 290, 310 on the collar 40 and the female connector 30, respectively, are manually aligned and the two bodies are pushed together along the longitudinal axis A-A to achieve a snap-lock. When the bodies are pushed together, the second body 30 receives the first body 10, as the boss 24 telescopes in the cavity 34 and the keys 230, 240 slide into the keyways 260, 270, respectively. At the same time, the camming tabs 210, 220 slide past each other. The collar camming tab 210 is  
15 offset a small angle from a central plane through the collar and receptacle to facilitate engagement. After first sliding engagement, the mutual edging action of the camming surfaces 341, 342 forces the collar 40 to rotate against the spring, i.e., in the radially backward direction, allowing the collar tab 210 to slide around the receptacle tab 220 and then spring back with its back surface 361 behind the back surface 362 of the receptacle tab  
20 220.

In this position, the tabs lock the first body 20 to the second body 30 through a predetermined range of forces. The spring 47 reverses rotation of the collar 40 until the faces of the collar stops strike the opposed faces of the plug stops. An audible “snap” signals that  
25 the first body 20, the plug, and the second body 30, the receptacle, are locked together. Locking may be visually confirmed by alignment of the index marks after the automatic return of the collar to its normal position by the spring. The camming tabs 210, 220 are configured to provide automatic release when a predetermined force is applied to one or both of the bodies.

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The connectors may be released manually, by rotating the collar 40 in the radially forward direction, or by applying a predetermined breakaway force to the connectors along the longitudinal axis A-A. To disengage the connectors, the collar 40 is manually rotated in the radially forward direction, as indicated by the arrowhead 300. The rotation of the collar

40 in the radially forward direction turns the collar camming tabs 210 towards a circumferential ramp 370 slanting across the paths of the tabs. The camming face of each ramp is angled away from the adjacent tab, so that it cams the collar tab 210, collar 40 and first body 20 apart and out of engagement with the second body 30. In this manner,  
5 disengagement can be effected without pulling and straining the cord extending from the plug, because the rotation of the collar is in a plane at right angles to the axis of the plug and cord.

The camming tabs are also configured to automatically disengage upon application of  
10 a predetermined breakaway force to either of the connector bodies. For example, as shown, the back surface 362 of the receptacle camming tab is angled relative to the direction of rotation of the collar 40 to provide automatic release upon application of a force along the longitudinal axis A-A that exceeds a predetermined value. The predetermined breakaway force is inversely proportional to the angle of the back surface of the receptacle camming tab  
15 relative to the line B-B. According to the illustrative embodiment, the back surface 362 of the receptacle camming tab 220 is angled about 10 degrees, as shown in Fig. 3, to enable automatic disengagement of the connector upon application of a force that exceeds the predetermined breakaway force. According to the illustrative embodiment, the predetermined breakaway force is between about one pound and about twenty pounds and  
20 preferably about ten pounds for the illustrated angle  $\theta$ . When a pulling force larger than about the predetermined breakaway force is applied, the sloping back surface allows the collar camming tab 210 to slide past the receptacle camming tab 220, releasing the connection without damaging the connector components and/or before damage to equipment or persons occurs. In contrast, the camming tabs described in the prior art have back  
25 surfaces which are substantially perpendicular to the longitudinal direction along axis A-A, which prevent the tabs from sliding past each other when a pulling force is applied along the longitudinal axis.

According to an alternate embodiment, a receptacle body 30' of the locking connector  
30 pair includes engagement recesses 300 formed in the exterior of a cavity 34', as shown in Figures 8a and 8b, in place of the camming tab and circumferential ramp. The engagement recesses 300 are configured to engage with the collar camming tabs 210 to temporarily lock the collar to the second body. Each engagement recess 300 includes a ramped wall 370' corresponding to the circumferential ramp 370 of the receptacle 30 of Figures 1-9, a



longitudinal wall 380 and a protrusion 220' forming a camming tab extending from the longitudinal wall 380. As shown, the protrusion includes a back wall 210a extending axially and radially forward from the longitudinal wall 380 at a predetermined angle relative to the line B-B and a camming wall 210b forming a camming surface for allowing the collar tab to slide past the protrusion 220' when slid along the longitudinal axis. The longitudinal wall 380 and the protrusion form a recess slot located axially behind the protrusion 220' for retaining the collar camming tab when the receptacle body 30' is engaged with the first plug body 20. As described above, the back wall 210a is angled by a selected amount to provide automatic release of the collar camming tab when a predetermined force is applied to the connector bodies.

According to another embodiment of the invention, the connector may be configured to increase the breakaway force between the first and second connector bodies, thereby reinforcing the connection between the first and second connector bodies. For example, as shown in Figure 9, one or more of the back surfaces 361'', 362'', preferably the back surface 362'' on the camming tab 220'' of the second connector 30'', is angled relative to a radial axis B-B that extends along the direction of rotation of the collar and to the longitudinal axis A-A, as shown in detail in Figure 9, to increase the breakaway force the first and second connector. As shown, the angled back surface 362'' of the receptacle tab extends in an inverse direction relative to the back surface 362 of the receptacle tab 220 of Figure 3. As shown, the back surface 362'' of the reinforcing tab 220'' is inclined from the radial axis B-B to form a ramp that extends at a negative angle  $-\theta$ , i.e., in a direction that is axially backward and radially forward from a back point 335'' of the camming tab 220''. According to the illustrative embodiment, the back surface 362'' of the receptacle camming tab extends at an angle  $-\theta$  to reinforce the connection between the bodies by urging an engaged collar camming tab 210 in the radially backward direction, away from the ramp 370. The configuration of the back surface 362'' thus inhibits sliding of the collar tab 210 toward the ramp, thereby preventing release of the collar tab 210 from the camming tab 220'' of the second connector 30''. According to the illustrative embodiment, the angle  $-\theta$  is between about 5 degrees and about 45 degrees relative to the line B-B, as shown in Figure 3, and relative to the back surface of the camming tabs described in U.S. Patent Number 5,067,909. One skilled in the art will recognize that the connector may have any suitable configuration for modifying the breakaway force between the first body and the second body.

The reinforced locking connector second connector body 30'' may alternatively include an engagement recess, corresponding to the engagement recess 300 shown in Figures 8A and 8B, including a protrusion, corresponding to the protrusion 220', having a back wall extending at a *negative* angle from a longitudinal wall. The reverse orientation of the back wall serves to prevent premature release of the connector bodies.

As described above, the back wall of a camming tab of a locking connector according to the present invention may extend at a *forward* angle relative to the radial axis B-B to decrease the breakaway force and allow for quick release of the connector bodies.

Alternatively, the back wall may extend at a negative angle relative to the radial axis B-B to increase the breakaway force and prevent release of the connector bodies.

One skilled in the art will recognize that the correlation between the angle of the back wall and the breakaway force depends on the type of material and properties of the material used to form the connector bodies. For example, for materials having a higher coefficient of friction, a relatively larger angle may correspond to a selected breakaway force, while materials having a lower coefficient of friction require a relatively smaller angle to obtain the selected breakaway force. According to the illustrative embodiment, the angle of the back wall of the receptacle camming tab is between about 5 and about 45 degrees relative to the radial axis B-B, in either direction, and the predetermined breakaway force is between about one and about forty pounds, depending on the configuration of the back surface of the camming tab, though one skilled in the art will recognize any suitable angle and breakaway force may be used in accordance with the present invention. One of ordinary skill in the art will be able to determine a suitable angle to provide a desired breakaway force in a connector system of the invention.

Furthermore, one skilled in the art will recognize that alternatively the collar may alternatively be mounted on the female connector and camming tabs may be provided on the male connector.

One skilled in the art will recognize that the invention is not limited to the illustrative automatic release mechanism and that other means of providing an automatic release mechanism may be used according to the teachings of the invention.

The rotating collar and camming tabs of the connector provide automatic locking engagement of the plug and socket without deformation of the plastic, insulative connector bodies or collar. Engagement is indicated positively by an audible snap and by alignment of index marks. The spring allows a rotary disengaging manipulation, which is convenient and  
5 which places no longitudinal strain on a cord or cable connected to the plug body. The connectors provide a secure connection up until a predetermined breakaway force and further allow automatic de-coupling of the connector system to prevent injury, damage to the connector bodies, damage to the cords attached to the connector bodies and/or damage to components attached to the connector bodies. The connector pair can be reused even after  
10 the bodies have been separated by the application of the predetermined force. The breakaway force can be modified by changing the angle of the back wall of the receptacle camming tab. Moreover, a receptacle body having a modified camming tab to allow for the automatic de-coupling can be used with current plug bodies, such as the male connector of the PULSE-LOK from Alden Products, described in U.S. patent number 5,067,909 without  
15 requiring modification of the plug body. In this manner, a connector system can be easily converted to provide automatic de-coupling at a predetermined without requiring replacement of all of the components of the system.

The present invention has been described relative to an illustrative embodiment. Since  
20 certain changes may be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings be interpreted as illustrative and not in a limiting sense. It should be understood that the present disclosure is for the purpose of illustration only, and that the invention includes all modifications and equivalents falling within the appended claims

25 It is also to be understood that the following claims are to cover all generic and specific features of the invention described herein, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

30 Having described the invention, what is claimed as new and protected by Letters Patent is: